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We Don't Have to Lose STEM Students to Business

Naomi L. B. Wernick[1]* and Fred D. Ledley[2]
[1]*Department of Biological Sciences, University of Massachusetts Lowell, Lowell, MA 01854;*
[2]*Department of Natural and Applied Sciences, Bentley University, Waltham, MA 02452*

Most undergraduate students who leave STEM majors before graduation choose careers in business. This article argues that better integrating business opportunities and context into the STEM curriculum could advance STEM learning, motivate students to remain in STEM as majors, and cultivate a constructive relationship between business, science, and society.

The attrition from STEM fields is recognized as a growing crisis, and millions of dollars have been spent in an effort to quell the tide. Many students who chose to embrace STEM majors when starting college, switch out in favor of a non-STEM field before graduating, while others who complete their STEM major choose careers in non-STEM fields after graduation (1–5). Moreover, recent census data suggest that only 27.1% of students graduating with STEM degrees enter the STEM workforce; the remaining 74.3% work in STEM-related or non-STEM careers (Fig. 1).

For clarification, STEM workers are those employed in science, technology, engineering, and mathematics occupations; this includes computer and mathematical occupations, engineers, engineering technicians, life scientists, physical scientists, social scientists, science technicians, and STEM managers. STEM-related occupations include architects, healthcare practitioners, healthcare managers, and healthcare technicians. While we do not discount the importance of STEM-related occupations, we are emphasizing the need for a large, diverse and vibrant workforce that will be actively focused on tackling the difficult scientific challenges that we currently face and will continue to face in the future. Furthermore, if one were to include STEM-related careers with STEM careers, this would still yield only 52.5% of students, which means that roughly half of STEM students are leaving STEM for non-STEM related careers.

This disparity becomes even more apparent when we examine the outcomes of underrepresented minority (URM) students; in this case, only 19.7% of students graduating with STEM degrees enter the STEM workforce, while the remaining 80.3% work in STEM-related or non-STEM careers (Fig. 2) (2). Again, if we include STEM-related careers with STEM careers, this number would still only be 44%, which is significantly less than the 53.9% of represented STEM students who pursue STEM careers after college. This attrition has resulted in universities offering increased early research experiences, more active learning in introductory STEM courses, and opportunities to join STEM learning communities (6).

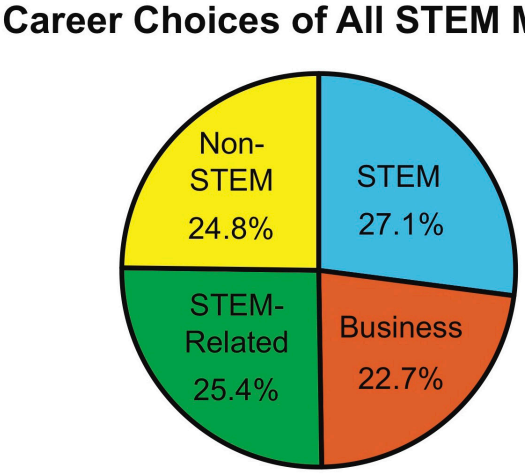

FIGURE 1. Career choices of all STEM majors.

While these efforts are important, we believe that not enough attention has been paid to the fact that most of the students who abandon careers in science choose, instead, to pursue careers in business. When examining the non-STEM career choices of science majors, the majority (roughly 23%) are managerial or business/finance-related. Interestingly, in the case of URM students, a number equivalent to the represented student population (21.1%)

*Corresponding author. Mailing address: Department of Biological Sciences, University of Massachusetts Lowell, 1 University Ave, Lowell, MA 01854. Phone: 978-934-3506. E-mail: naomi_wernick@uml.edu.

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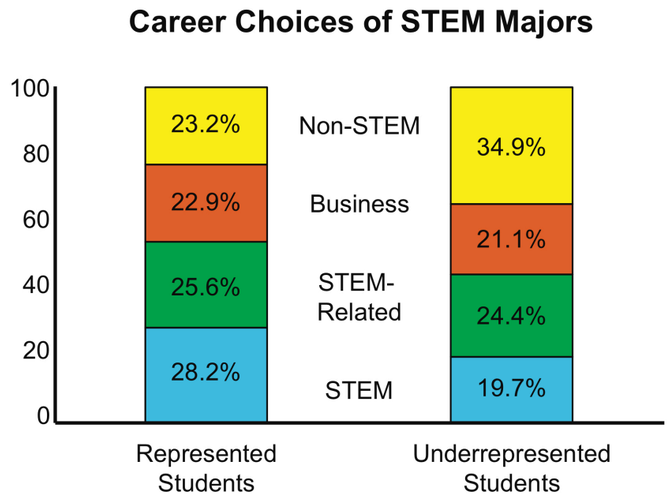

FIGURE 2. Career choices of represented and underrepresented STEM majors.

pursue business careers; however, the number of URM STEM students pursuing non-STEM career choices grows to 34.9% (in comparison with 23.2% of represented students). Furthermore, if we include those students who leave STEM prior to achieving the bachelor's degree, we find that nearly 25% of these students ultimately switch to business majors (2). This represents the largest single cohort of students leaving science.

What is attracting students to business? One possibility is increasing concern about the return on investment in a college education and the perception many students have that working in business is both exciting and lucrative (7). Furthermore, the loss of STEM students to business may be exacerbated by the fact that science courses often portray science as being in conflict with business.

Business is anathema to many academic scientists, who often point to efforts by "big tobacco," "big oil," and "big food" to undercut important scientific insights and initiatives. In fact, a recent study showed that introductory biology textbooks overwhelmingly portray business in a negative light, focusing on companies that pollute, engage in unsustainable practices, or endanger human health (8). Therefore, students are presented with a largely binary choice between a scientific way of knowing, and that of industry.

We believe this is a mistake. Without minimizing the real conflicts that exist between science and business, this portrayal of business as being antithetical to science disregards the even stronger connections that exist between science and business. It ignores the essential role business plays in translating scientific discoveries into products that benefit the public, the large number of STEM professionals engaged in industrial research and development, and the positive impact that a scientifically trained workforce can have on shaping business practices. The important synergies between science and business underlie the design of Professional Science Master's (PSM) programs, which provide students with advances in both scientific and business skills and allow them to apply both their scientific training and perspectives in business (9–11).

We believe that student engagement, enrollment, and persistence in STEM education could be advanced by curricula that communicate the synergies between science and business, rather than the conflicts. Introducing scientific concepts in a business context, presenting role models for scientific careers in business, and encouraging students to recognize how scientific training can contribute to business success would show students who are attracted to the opportunities inherent in business that they may choose to pursue their goals through STEM majors, rather than having to leave science for a business education.

One body of research demonstrates that what motivates students most in undergraduate education is how their studies will impact their ability to achieve a successful career. A series of focus groups conducted by the American Association of Colleges and Universities, for example, found that the number one motivation of students for attending college was to achieve competitiveness in the job market (12). More specific to science, a study of nonscience majors found that student motivation and ultimate achievement in science courses was greatly impacted by the belief that science is relevant to their careers (13). Student motivation, in turn, drives classroom engagement and, ultimately, persistence and retention (14, 6).

The expectancy-value theory of achievement motivation relates an individual's motivation to their belief in their ability to succeed as well as how they perceive the ultimate value of the task at hand. Task value can be broken down into several components: the perceived usefulness of a task, interest in a task, and the perceived importance of the task (14). In particular, one value of any educational task could be its perceived role in enhancing one's career prospects. Certainly, as concern about the value of a college education has grown, this perceived task value is also increasingly related to its role in improving a student's earning potential.

Often, this earning potential implicitly relates to careers in business. In this context, incorporating curricular elements that place science in a business context could increase student motivation to engage in STEM education and, consequently, persistence and retention. Teaching students that there are many opportunities to apply science in business would increase the likelihood that they will complete a STEM major. While we are not aware of research confirming this supposition, when PSM students are asked why they entered a PSM program, the dominant factor is the impact the program will have on their professional development and preparation for a career (15). Therefore, integrating some of the business perspectives of the PSM into undergraduate science education could both improve performance and better prepare STEM graduates for the diverse opportunities available after graduation.

Teaching science in context has already been applied extensively in chemistry education. Context-based chemistry textbooks show students early in their careers the relevance of their education to solving real-world problems (16). This approach has been found to enhance students' intrinsic motivation to learn as they understand the value of their learning (17). This method also prepares students for the workforce by giving them experience and practice in solving the types of complicated problems they may face in their careers. Furthermore, at least one study has shown the importance of a student's development of career aspirations to their science identity and motivation in the classroom (18). Clearly, it is of value to consider students' future career prospects and goals in our teaching, by demonstrating instances of science in the context in which many will be utilizing this knowledge.

One method of introducing students to these real-world problems is through the use of case studies. Case studies are a well-established pedagogical approach to engaging students in learning, not only in professional education, but also in science (19, 20). Cases could be developed to introduce students to applications of science to developing new foods or pharmaceutical products, to healthcare, and to sustainable business practices. Other cases could examine product development in the context of the "complexities of business, intellectual property protection, and a regulatory environment that is largely political—the real interface between sciences and the liberal arts education" (21). Combining instruction in scientific concepts and practices with examples of how science can lead to new products and improved business practices could better engage students in science as well as expose them to a multitude of exciting career possibilities (22). In introductory STEM courses, such cases could increase the task value associated with learning and speak directly to students' intrinsic desire to be best prepared for future careers. Ultimately, this could lead to increased persistence within the STEM major.

We are not proposing that STEM education should promote careers in business or ignore instances of antiscientific, fraudulent, or unsustainable practices by industry. Rather, we propose that educators should recognize that the largest fraction of students who enroll in science courses will choose to pursue careers in business and work in industry, and that the goals of STEM education could be better achieved by teaching science in such a way that leads students to appreciate the value of a science on their life path. Moreover, if we promote heuristics that reinforce the positive contributions of science to industry, our graduates are more likely to be able to apply STEM learning in their careers (8).

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REFERENCES

1. Wisconsin Center for Educational Research. Talking about leaving, revisited. http://talr.wceruw.org/.
2. Chen X. 2013. STEM attrition: college students' paths into and out of STEM fields. Statistical Analysis Report. NCES 2014-001. National Center for Education Statistics.
3. Landivar LC. 2013. The relationship between science and engineering education and employment in STEM occupations. American Community Survey Reports, US Census Bureau, Washington, DC.
4. United States Census Bureau. 2014. Table 5. Employment in STEM occupations by field of degree for the first listed bachelor's degree: 2012. US Census Bureau, Washington, DC.
5. United States Census Bureau. 2014. Where do college graduates work? A special focus on science, technology, engineering and math (data table). US Census Bureau, Washington, DC.
6. Graham MJ, Frederick J, Byars-Winston A, Hunter AB, Handelsman J. 2013. Increasing persistence of college students in STEM. Science 341(6153):1455–1456.
7. Easterlin RA. 1995. Preferences and prices in choice of career: the switch to business, 1972–1987. J Econ Behav Organiz 27(1):1–34.
8. Simon SM, Meldrum H, Ndung'u E, Ledley FD. 2018. Representation of industry in introductory biology textbooks: a missed opportunity to advance STEM learning. CBE Life Sci Educ 17(ar61):1–13.
9. Schuster SM. 2008. Commentary: the professional masters degree. Biochem Mol Biol Educ 36(5):365–366.

10. Colwell RR. 2009. Professional science master's programs merit wider support. Science 323(5922):1676–1677.
11. Lynch C. 2012. The case for professional science master's degrees. BioScience 62(8):705–706.
12. Humphreys D, Davenport A. 2005. What really matters in college: how students view and value liberal education. Liberal education & America's promise. Lib Educ 91(3):36–43.
13. Glynn SM, Taasoobshirazi G, Brickman P. 2007. Nonscience majors learning science: a theoretical model of motivation. J Res Sci Teach 44(8):1088–1107.
14. Wigfield A, Eccles JS. 2000. Expectancy-value theory of achievement motivation. Contemp Educ Psychol 25(1):68–81.
15. Allum J. 2013. Outcomes for PSM alumni: 2012/13. Council of Graduate Schools, Washington, DC.
16. Gutwill-Wise JP. 2001. The impact of active and context-based learning in introductory chemistry courses: an early evaluation of the modular approach. J Chem Educ 78(5):684.
17. Vaino K, Holbrook J, Rannikmäe M. 2012. Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. Chem Educ Res Pract 13(4):410–419.
18. Perez T, Cromley JG, Kaplan A. 2014. The role of identity development, values, and costs in college STEM retention. J Educ Psychol 106(1):315.
19. Herreid CF. 1994. Case studies in science—a novel method of science education. J Coll Sci Teach 23(4):221–229.
20. Herreid CF. 1997. What is a case. Bringing to science education the established teaching tool of law and medicine. J Coll Sci Teach 27(2):92–94.
21. Schuster SM. 2008. Critical skills in biotechnology education. Biochem Mol Biol Educ 36(1):68–69.
22. Schuster SM. 2006. Commentary: a case for expanding the scope of case studies in biotechnology education. Biochem Mol Biol Educ 34(1):52.